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UNITED STATES
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HAROLD L. ICKES, SECRETARY

BUREAU OF MINES
R. R. SAYERS, DIRECTOR

INFORMATION CIRCULAR

ACCIDENTS DUE TO MISUSE OF EXPLOSIVES

BY

D. HARRINGTON AND J. H. EAST, JR.

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UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

ACCIDENTS DUE TO MISUSE OF EXPLOSIVES[1]

By D. Harrington[2] and J. H. East, Jr.[3]

Misuse of explosives and heedless disregard of well-known safety rules covering the use of commercial explosives cause many avoidable accidents resulting in the death or maiming of men who can ill be spared by already undermanned industry at present, and who cannot be spared by their families at any time. Blasting accidents, when not fatal, are usually serious; the past and present needless loss of life and maiming of men from this cause are appalling and types of waste that can and should be virtually eliminated. Dead, crippled, and maimed men are distinct losses to society as well as to industry, and compensation payments for such accidents represent only a portion of the financial loss, because the value of their lost potential production can only be surmised.

By their very nature, explosives are dangerous to handle, otherwise they would not perform the services for which they are used; all men on a blasting crew are subjected to the results of the carelessness of any one member, and in many instances the misuse of explosives by one person has killed scores of fellow workers. Inexperienced men should be assigned to blasting operations only under the close supervision of men well-experienced in the work and familiar with its inherent hazards. Men should be selected for blasting crews that are known to be careful, willing to follow instructions, cool-headed, and unlikely to become excited in an emergency; they should be instructed in the safe handling of explosives in accordance with the safety rules established by the explosives-manufacturing companies or the safety codes of the various industrial organizations. Unfortunately, American industry has never adopted a uniform code for the safe handling of explosives; however, many mining companies have made rules that will eliminate most unsafe practices if established safe procedure is followed carefully. The Bureau of Mines has issued numerous pamphlets giving information on the causes of accidents due to explosives in the mining industry and indicating the ways in which a good proportion of those accidents can be avoided.

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Close supervision of men working with explosives will eliminate much of the common carelessness; unfortunately, supervision of blasting is likely to be lax rather than close, not only in war time but also in peace time. Accidents from explosives usually are so severe that no individual has a very good opportunity to learn by his own experience, and many are disinclined to learn from that of others. Some companies adopt safety rules; yet, especially in times of stress (as in the present war-time demand for production) the supervisory staff is more interested in attaining maximum daily output than in requiring that it be attained safely. High accident rates result almost invariably under these conditions, and accidents from explosives are almost certain to contribute to the increased accident occurrence.

Many careless practices in handling and using explosives are due to placing new men with experienced men who have not been trained in safe methods of blasting but whose experience has been gained in essentially the same way; thus dangerous practices are handed down from one man to another.

Unquestionably far too many people in the United States are allowed to possess and to use explosives with very inadequate knowledge of the hazards of explosives or of safe ways of using them.

A few out of scores of examples of relatively recent misuse of explosives have been compiled in this circular to emphasize the necessity for giving closer supervision to men engaged in blasting and to educate and train these men in safer methods.

EXAMPLES OF MISUSE OF EXPLOSIVES

Kentucky Mine

Within 10 days two men in one mine each lost the thumb and three fingers of the left hand while placing fuse in detonators preparatory to blasting.

One man had over 30 years of experience in mining work; the other less than 2 years of mining experience. In one case two detonators were procured by the victim from a cache on some timbers placed there by another man, and the supposition is that some foreign substance had entered the detonator, which exploded prematurely as the fuse was being placed in the detonator barrel by pressure and twisting.

In the other case the victim states that the covering of the fuse was loose and unwrapped and was "hard to place in the cap so I gave it a hard push and twist at the same time when the cap exploded." The man had four detonators left over from the previous shift and took them home, presumably loose in his pocket; again it would appear that some foreign matter probably entered the barrel of the detonator.

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In both instances there was definite carelessness in the storage and transportation of the detonators before use; it is very unsafe to place two loose detonators on a timber for storage or safekeeping, as was done in the first case (and is done far too frequently in all kinds of mining work), and carrying four extra detonators home, probably loose in the pocket, is extremely careless. The methods of transporting and storing detonators (as well as of using them) in this mine were anything but safe; this is the primary cause of these two accidents, and each ruined the left hand of the victim. In both the victim was using an electric cap lamp, hence open lights cannot be held responsible; in both cases No. 6 detonators were used, and there is little or no suspicion that these were defective, inasmuch as the methods of use were very evidently at fault.

Remarks:

Forcing fuse into the barrel or cylinder of a blasting cap or twisting the fuse when in contact with the explosives charge of a blasting cap invites an explosion; for many years the explosives-manufacturing companies have specifically warned against this practice. The instruction of employees in the safe methods of working should be considered a responsibility of management; moreover management should prescribe and enforce safe methods of handling and storing as well as using explosives.

North Carolina Mine

A North Carolina mica mine was being unwatered and prepared for operation in June 1943. The mine workings consisted of a tunnel 300 feet long, which connected with a slope on a 30-degree incline 200 feet long.

All shots were fired electrically from outside the tunnel, using a standard plunger-type blasting machine. The blasting lines were suspended from bent nails in mining timbers about 6 feet from the floor. The foreman did all the blasting.

The slope was too narrow to permit a new 2-ton car to pass, and it was necessary to widen it at one point. The driller finished drilling a horizontal hole, and the foreman went to the surface for explosives. The driller stated that the foreman, on returning, loaded the hole and connected one leg of the electric detonator to the blasting line; when he attempted to connect the second leg wire the shot went off, fatally injuring the foreman and severely injuring the driller.

The blacksmith stated that the victim had connected an electric hoisting signal actuated by a "hot-shot" battery to the blasting line about 2:30 p.m. the same day. The driller walked out of the tunnel after the accident and sent the blacksmith to help the foreman. The blacksmith noticed that the "hot-shot"

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battery was still connected to the blasting line when he entered the tunnel. The men were taken to the hospital, where the foreman died the same night.

Remarks:

Blasting lines should be used only for blasting, and the lines should be so arranged they cannot be charged accidentally; one procedure toward accomplishing this is to connect the blasting lines to safety switches locked in the open position, thus sectionalizing the lines.

Blasting lines should not be extended beyond the mine workings at the surface unless an air gap is provided inside the mine to prevent accidental charging of the lines by lightning or other sources of electricity. The connection for the air gap should be kept locked in the "open" position until the line is ready for use.

Colorado Mine

Two men were injured in a Colorado coal mine in May 1943 when a Cardox shell was ejected from a hole and ricocheted around two right angles, striking the men.

The face of the back entry was about 25 feet beyond the last crosscut and had been undercut to a depth of 6 feet. One 6-foot hole had been drilled in each side about 2 feet from the rib. The shot firer pushed a 5-1/2-foot Cardox shell to the bottom of the hole and then pulled it back 10 or 12 inches, so that about 3 inches of the shell protruded from the collar of the hole; he then wedged the shell in that position. The shot firer and two miners walked through the crosscut into the main entry toward the face, placing two right angles between themselves and the shot. The Cardox shell was ejected from the hole when fired and struck two timbers about 25 feet from the face, which deflected the shell into the crosscut. The shell struck the outby rib of the crosscut (see fig. 1) and was deflected again, this time into the main entry, striking the two miners and narrowly missing the shot firer. The shell finally stopped when it struck a timber about 25 feet from the face. The eye of one miner was gouged out, and the other miner suffered lacerations of the head and face. The blasting cable was only 52 feet long.

Remarks:

The use of a short blasting cable when Cardox or any other explosive is fired should not be tolerated; a blasting cable should be at least 100 feet long.

Flying Cardox shells are a real hazard in this type of blasting, and while it is usually held that safety can be expected if two right angles intervene, this

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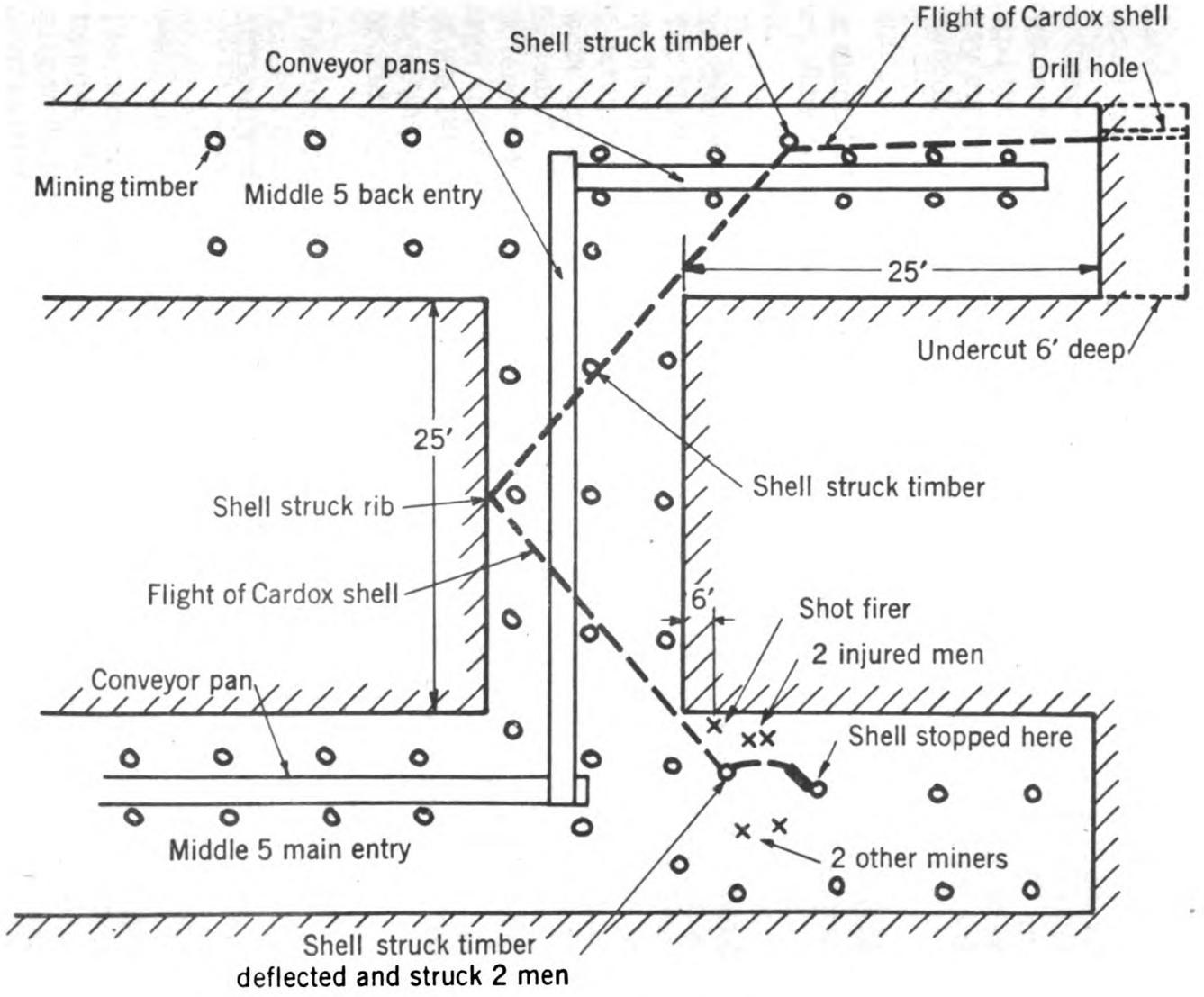

Figure 1. — Accident caused by ricocheting Cardox shell.

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case indicates very definitely that is is safer for men to stand around two right angles that are in a reverse direction than when the two right angles are in the same direction. The prevention of accidents from flying Cardox shells constitutes a real problem, and to date none of the proposed preventive methods solves the problem completely.

Oregon Logging Operation

An Oregon logging operation was about completed in May 1943, and only a few logs remained to be sent to the sawmill. It was necessary to blast some stumps and tree "snags" out of the swing road. The hook tender ("straw boss") and donkey engineer went to the operation on Sunday; the hook tender proceeded into the woods to do the required blasting while the donkey engineer adjusted the engine.

An electric horn is used for signaling from the woods to the donkey-engine operator. The circuit wires are taken as far into the woods as is necessary for the work.

The donkey-engine operator stated that the hook tender was using the signal circuit for blasting. He had broken one wire of the signal circuit some distance from the place where he was working while he connected the leg wires of the electric detonator. Six or seven shots had been fired, which the operator believed were springing shots; then there was a heavy explosion, and the signal bell began to sound. The operator went into the woods to investigate and discovered the hook tender dead. He believes that a half to a full case of dynamite was in the charge and that it was detonated when the deceased connected the 4-foot leg wires of the detonator to the signal circuit. The explosion threw the signal wires together, causing the horn to sound. Inspection revealed that the two ends of the broken signal wires had come together, making a contact.

The company provided a blasting machine and special lead wire; but men, in this case a boss, did not like to carry any extra weight in the woods because of the difficulty of traveling over the rough ground.

Remarks:

The deceased evidently was not an experienced blaster or he would not have attempted to connect the detonator leg wires to a live signal circuit, especially when the leg wires were only 4 feet long. The assignment of untrained men to occupations, such as blasting, that require special skills is hazardous in the extreme. The company provided safe blasting equipment but did not require its use, hence supervision was lax even though, as in this instance, the work was done by a supervisor and the accident occurred to him.

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Laxity in keeping in effect the precautionary procedures known to be essential in preventing accidents from explosives is one of the problems likely to be encountered in connection with persons in charge of blasting operations. However, the supervisors themselves should be carefully supervised, at least as to explosives procedures.

Texas Mine

Two men were killed in a blasting accident while blasting in a shaft at a Texas mine in February 1943 owing to underestimating or more probably not being acquainted with the burning rate of fuse.

The shaft was 350 feet deep at the time of the accident, and the nearest safe refuge at blasting time was the 300-foot level. The men climbed to their refuge after lighting the fuse when blasting a shaft round. The shaft work had been in progress about 3 months preceding the accident, and an average of two rounds was blasted each week. The explosives were detonated with caps and fuse, always a dangerous method in shaft sinking.

The shaft foreman stated that 19 holes had been drilled and each one loaded with four sticks of dynamite. Normally, 6-foot fuse was used. He said, "This meant 6 minutes would be used to set off the dynamite, as the fuse burns a foot a minute. After lighting the 19 fuses, the miners climbed up the ladder to the safety station 50 feet above." On the day of the accident the miners had trouble in lighting the fuse, and the foreman who was waiting about 8 feet up the ladder timing the fuse observed that 4 minutes had elapsed so shouted to the men to get out as only 2 minutes remained; one of the miners replied there was plenty of time and to wait for him. The foreman shouted several times for the men to get out and started up the ladder, but the miners did not follow. The shots exploded and the men were killed.

Remarks:

The blasting practice in this shaft is very badly planned; the use of 6-foot fuse when 19 holes are to be lighted and the men required to climb 50 feet to safety is inexcusable. The foreman said that he held a watch, and it was agreed that all should retreat when 4 minutes had elapsed after the first fuse had been spit, under the assumption that the fuse burns at a rate of a foot a minute; hence after 4 minutes elapsed from the first spitting a "cushion" of 2 minutes would remain to permit escape. As a matter of fact, present-day fuse usually burns at a rate of about 40 seconds per foot of fuse; hence, at the end of 4 minutes the flame in the first fuse that had been spit should have traveled just 6 feet (240 ÷ 40 = 6). Evidently the fuse performed in accordance with what it should have done, and these men were the victims of lack of knowledge of the characteristics of the fuse being used.

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Unquestionably many old timers were told that the burning speed of fuse is (or was) 1 foot per minute, and the men at this particular mine still held that idea. It would appear that some educational work is needed to dispel the "foot-a-minute" idea as to the burning speed of fuse; it is suggested that those who read this item should do their part of this educational effort.

The burning rate of fuse should be determined frequently, and should be posted prominently throughout the mine.

Electric blasting is generally a much safer method to use in shaft work, even though it too is anything but foolproof.

California Mine

A blasting accident occurred in a California open-pit gold mine in 1940 while jackhammer holes were being sprung preparatory to loading a primary blast.

The drill holes were about 10 feet deep and were being sprung with 40-percent gelatin dynamite detonated with a No. 8 blasting cap and 20 to 24 inches of single-tape fuse. The foreman heard an explosion and on investigation found the blaster partly conscious, with his right hand blown off at the wrist and injuries to his face and eyes. The blaster stated that while he was attempting to spring the hole a rapid fuse caused premature explosion of the stick of explosives before he could drop it into the hole.

Test pieces from the same roll of fuse revealed a uniform burning rate, and it is believed that the accident was caused by a short fuse and not by a rapidly burning one. The blaster may have delayed dropping the primer into the hole longer than he realized, and it exploded in his hand.

Remarks:

Short fuse has caused numerous accidents, and in many States the minimum length of fuse permitted in any kind of work is regulated by law; it would appear that no fuse should be shorter than 30 inches, and preferably the minimum length should be 36 inches. After spitting, 2-foot fuse gives no more than 80 seconds before detonation, and that is far too short a period to allow a person to escape to a safe place when a procedure as violent and destructive as blasting is concerned. Practically all of the so-called racing fuse is short fusing or possibly an erroneous calculation of the burning rate of fuse as 1 foot a minute instead of approximately 1 foot in 40 seconds.

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New York Farm

Explosives stored in a magazine on a New York farm were detonated in April 1943 by bullets from a .22-caliber rifle fired by two boys. One boy was killed and the other injured seriously.

The magazine was of steel plate of a type frequently used and was leased to the owner of the farm. The magazine was not lined to make it bullet-resistant and was not barricaded. Danger signs were placed on the magazine, which was surrounded by a thick growth of trees measuring 6 to 12 inches in diameter at the base.

Records show that the magazine contained 1,000 pounds of 40-percent gelatin dynamite, 1,149 pounds of ammonia dynamite, 150 pounds of TNT, and a box containing 5 M. A. land mines.

The investigation of the explosion revealed that two boys, one 13 and the second 16, were walking through the woods shooting at various objects with .22-caliber rifles. One of the boys shot at a small building from a distance he thought was 150 feet, and the explosion resulted. One boy was able to run for help, and both boys were taken to the hospital where one died the same night.

Remarks:

Magazines that are not at least bullet-resisting are a constant source of danger. Irresponsible people use firearms, as in the case of these boys, and isolated magazines frequently are made targets, as people do not realize the danger involved. Boys 10 to 15 or 16 years of age have been getting into trouble to an increasing extent in recent years in connection with explosives. In at least two instances within the past 5 years, five children were killed; in each instance small boys fired .22 rifle bullets into explosives. There are numerous cases of theft of explosives from magazines by boys less than 16 years old.

Danger signs in connection with explosives magazines should be so located that a bullet passing through the sign will not strike the explosives in the magazine; preferably this sign should be on a post, tree, or other place in the vicinity of the magazine.

Alabama Mine

A fatal blasting accident that occurred at an Alabama open-pit iron mine in 1940 resulted in the death of two men and injury to another when they returned to what was believed to be a misfired drill hole.

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A steam shovel was waiting for ore to be blasted in the pit. The face and bottom of the ore cut were wet. Three holes were drilled 4-1/2 feet apart; one hole 4-1/2 feet deep was loaded with six sticks of 1-1/8- x 8-inch 40-percent dynamite; the second hole was 3 feet deep and loaded with four sticks of dynamite; and the third hole was 4-1/2 feet deep and loaded with six or seven sticks of dynamite. Caps and fuses were used for blasting, but the fuses were cut in indefinite lengths ranging from 20 inches to 4 feet. The fuses were lighted and the men retired about 100 feet to shelter. One of the men said he failed to light the fuse in No. 3 hole, so after two shots exploded the men returned to the shovel pit. Three men were moving the blasted material and uncovered the fuse of No. 3 hole. One man picked up the fuse about 6 inches from the end, and the hole exploded, killing two of the men and injuring a third man. The fourth man of the party escaped uninjured. Evidently the powder train in the fuse No. 3 hole was damp and did not light quickly but did ignite and probably burned normally after passing the damp spot. The difference in time in exploding the holes was also due to the wide variation in the length of the fuse.

Remarks:

These men probably were unfamiliar with blasting operations, as the length of fuse used on multiple shots is very important. Blasters should be skilled workers, and only men experienced in this type of work should be so employed. Blasting rules should be made very stringent, particularly regarding the waiting time if a hole misses.

Utah Mine

A blasting accident occurred in a Utah open-pit mine in 1940 and caused the death of three men. The men were lighting the fuses and inserting the primers in the drill holes when the premature blast occurred.

Twelve 2-inch drill holes 23 feet deep and slightly inclined from the vertical had been sprung and were loaded with four to four and one-half cases of explosives. Springing holes usually causes them to ravel, making it difficult to place the explosive at the bottom; hence a 1-1/2-inch pipe about the length of the hole is inserted in the hole to be loaded, and 12 to 15 sticks of explosives are placed in the pipe and pushed to the bottom of the drill hole. This is continued until a full charge of 4 or 5 cases of explosives has been loaded. The metal pipe is left in the hole until the primer with a spit fuse is pushed through the pipe and is then removed if it comes out freely; otherwise, it is left in the hole. The primer is made by placing two blasting caps in a stick of dynamite attached with fuses 6 feet 2 inches long brought out on opposite sides of the same stick of explosives and taped to the cartridge. Both fuses are spit, and the primer is placed in the pipe and pushed to the bottom of the hole. The dynamite cartridges are 1-1/4 by 8 inches.

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A 1-1/2-inch-diameter pipe could not be used in one hole and a 1-1/4-inch-diameter pipe was substituted. The men anticipated trouble in loading 1-1/4- by 8-inch cartridges through the 1-1/4-inch-diameter pipe so slit the paper of the primer cartridge and removed some of the explosive to reduce its diameter. Other blasters began to light the other holes, and the deceased men lighted the fuse of the specially prepared primer and started to push it through the 1-1/4-inch-diameter pipe, but it wedged in the pipe. A regular primer, made up of a 1-1/4-x 8-inch cartridge with 6 feet 2 inches of fuse attached, was inserted in the pipe and pushed down on top of the first primer, and the explosion occurred. The foreman and the other blasters had shouted to the deceased to leave the hole and run without trying to insert the second primer. It is believed that the heat from the crumpled fuse of the first primer caused the second primer to explode.

Remarks:

The blasting method appears to be unusually dangerous, but attempting to push a second primer on top of the first with the fuse burning was inviting a premature explosion. Closer supervision probably would have prevented this accident.

Nevada Mine

A fatal blasting accident occurred in a Nevada mine in 1940, when a miner attempted to force a wedged stick of dynamite containing an electric detonator into a drill hole.

Two men had drilled three holes and were loading them at the time of the accident. A delay electric exploder, probably a fifth delay or longer, had been found in the muck pile from blasting the previous round of holes, and the miners intended to dispose of the detonator by placing it in one of the loaded holes. The practice in making up the primers was to slit the stick of dynamite along one side for its full length and place the detonator in the exposed dynamite.

A miner placed the primer cartridge in the hole and attempted to push the cartridge containing the delay detonator to the bottom; but it wedged in the hole, perhaps due to protrusion of the detonator from the side or the end of the cartridge. The miner attempted to force the explosives into the hole, using both hands on the wooden tamping stick, and the explosion that resulted blew off his left hand and lacerated his other hand; rock penetrated both eyes, and he had numerous other injuries. He died the following day. The second man was standing about 2 feet from the deceased at the time of the explosion and escaped with minor injuries; he was wearing goggles and received numerous small cuts around the eyes; the goggles probably prevented serious injury to his eyes.

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Remarks:

Destroying blasting caps and detonators by placing them in a drill hole that is being loaded has caused many accidents, and some of them resulted in one or more fatalities. This practice should be prohibited.

A good method of destroying blasting caps or electric detonators is to dig a shallow pit not less than 12 inches deep and place in it the defective caps, tied in a bundle or otherwise attached to a good detonator or capped fuse, fill the pit with dirt, and fire in the usual manner. The pit should be dug in an out-of-the-way place where chance flying pebbles can do no harm.

Blasting caps and electric detonators should never be placed in shallow streams or ponds to destroy them. This method is ineffective and has caused many accidents.

Primer cartridges (sticks of explosives containing an exploder) should never be forced or "rammed" into a drill hole; this is especially hazardous with certain types of delay detonators and is always a menace when the detonator does not parallel the axis of the stick of explosives.

Iowa Quarry

The owner of an Iowa quarry was electrocuted in 1942 when the lead wire used to fire a quarry blast was thrown against a 6,600-volt power line.

The quarry is on the east side of a highway, and the face is about 60 feet distant. A power line carrying 6,600-volts is also on the east side of the highway on posts about 25 feet high. The shots were connected in series and the lead wires taken to the road; the blast was fired with the magneto of an automobile. The lead wire was thrown in contact with the power line while the quarry owner was holding the wires, and he was electrocuted. Artificial respiration and an inhalator failed to revive the victim.

Remarks:

Electric blasting should not be permitted under or near electric power lines where there is danger that the lead wire may come in contact with live wires. The lead wires should always be placed on the side of the blast away from any power lines, and the shot should be fired from a blasting unit.

Washington Quarry

A premature explosion of dynamite occurred while a recently sprung drill hole was being loaded at a Washington quarry in April 1943. One man was instantly killed and a second man severely injured.

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A blaster had sprung a 20-foot bench hole, using 10 cartridges of 1-1/8- by 8-inch 40-percent gelatine dynamite, and after waiting approximately 10 minutes began to charge the hole. He had placed six or seven cartridges of dynamite in the hole when the blast occurred. A miner who was about 25 feet away at the time of the explosion stated the blaster usually sprang the bench holes three or four times, using 10 cartridges of dynamite on each spring. The blaster was instantly killed, and a helper was severely injured.

Remarks:

Drill holes that are being sprung should always be allowed to cool before a second springing charge is loaded. This period of waiting time varies with the charge and with the character of the rock but should never be less than 2 hours for a small charge; a longer waiting period is safer.

Various methods are used to determine whether drill holes have cooled sufficiently to be loaded safely after springing; these include pouring water into the hole. In some cases the hole temperature is ascertained by inserting the wooden tamping bar in the hole and letting it remain for some time, and even by lowering a thermometer into the hole. However, if the charge of explosives used for springing a hole is more than a few sticks, the only safe way is to permit the hole to cool at least over night.

Wyoming Mine

A shot firer in a Wyoming coal mine was instantly killed by the delayed explosion of a Cardox shell in December 1942.

He had attempted to complete blasting the coal face in a room. Two Cardox shells had failed to function properly owing to defective condition, and the shot firer withdrew the last shell from the drill hole, removed the wiring from both shells, and coiled the battery cable. He then started for the supply station, taking the blasting battery and two defective shells with him. He reached a point on the main slope about 240 feet from the room face and met the rope rider. The rope rider stated the shot firer was carrying both shells on his shoulder as he approached and could see that one shell was leaking near the shell head. The shot firer was some distance from the rope rider, and as he started to talk the shell exploded. The rope rider was only slightly injured, but the shot firer was killed.

Remarks:

A misfired shot is dangerous, whether explosives or Cardox are used, and a definite waiting time should be observed before the firer returns to the hole; this is true as to electric as well as fuse blasting. The State of Wyoming Safety

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Rules required the shot firer to wait 15 minutes before returning to a misfired Cardox shot, and 15 minutes is the absolute minimum time period that should elapse before returning to a misfired shot of any kind or in any place.

Colorado Well

A man was seriously injured in June 1943 while attempting to blast a sewerage water-disposal well in a small Colorado town. A well 23 feet deep with a 6-inch casing was used to dispose of the water from a small sewage septic plant that drained into it. The interior of the casing had corroded and blocked.

The injured man attempted to place one stick of 40-percent dynamite with a capped fuse 2 feet long in the casing to blast the obstruction. The man lighted the fuse and started to push the dynamite into the proper position in the pipe, using a 2- by 2-inch stick of wood 5 feet long as a tamping stick. He made several unsuccessful attempts to place the dynamite and then pulled the dynamite cartridge from the hole; and as he started to pull the capped fuse from the dynamite it exploded in his hand. The injuries included loss of the left hand and one third of the left forearm, lacerations of the face, puncture wounds of the lower extremities, and injury to the left eye that may result in the loss of 90 percent of the vision of that eye.

The owner of the well was present when the accident occurred and stated that as the injured man pulled the explosives from the pipe the owner had shouted to the victim to throw away the dynamite; but the injured man replied that he knew he had plenty of time because he had a 20-minute fuse.

The injured man claims to have used explosives for approximately 20 years in the irrigation district, but the work was confined to shooting occasional adobe shots and holes in rock to obtain riprapping for irrigation ditches. It is stated that shooting these wells is a common practice in that area.

Remarks:

This accident was due entirely to permitting an inexperienced man to use explosives; a positive knowledge of the burning rate of fuse is essential at all times, and no blasting should be done unless the person doing it has had enough experience, by observation or otherwise, to realize the extreme necessity of being very careful with explosives.

Employees should be instructed in safe methods of handling explosives and should also be instructed in the dangers of not following safe practices.

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CONCLUSIONS

These examples of the misuse of explosives and faulty blasting practice by no means constitute a complete list of commonly encountered, man-created hazards in using explosives, but they do present a few samples of some of the foolish things that should not be done when explosives are handled or used. Blasting accidents are nearly always serious, resulting in death, dismemberment, or maiming of the careless individual and frequently of innocent bystanders; a determined educational campaign in safe blasting practices is well worth while in any organization that uses explosives. Ultimately rigid laws should be enacted requiring that all persons who engage in blasting shall have a certificate of competency issued by the State after the applicant has passed a rigid examination embodying fundamental facts on the characteristics and hazards of explosives.

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